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UTILIZATION OF PIMA COTTON.

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INTRODUCTION.

In establishing the production of the Egyptian type of cotton in Arizona many problems have been met, including the development of a special variety called Pima, which is better adapted to the Arizona and California conditions than any of the imported Egyptian varieties. This new type of cotton was at first used almost exclusively in the manufacture of tire fabrics, but during the recent business depression the tire trade was greatly restricted, and Pima cotton could not be sold at remunerative prices. These conditions were largely responsible for the recognition of the need of a more general study of the textile qualities of this class of cotton, to determine its adaptability to more general use in the fine-goods trade. The general result of this study is to show from actual data and experience of manufacturers that the Pima cotton can be used to advantage and is actually being used for many purposes of fine spinning and that the chief obstacle to more general use is the lack of assurance to the manufacturers that sufficient quantities of uniform fiber can be obtained.

A rapid increase of production followed the first commercial planting of 275 acres of this variety in the Salt River Valley of Arizona

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in 1916, until approximately 180,000 acres were planted in 1920. Plantings in other irrigated valleys in Arizona and California brought the total acreage up to approximately 250,000. The high prices of the war period and the restriction of Egyptian imports stimulated this development, so that Pima cotton figured as the chief crop of the southwestern valleys. But before the 1920 crop was harvested the United States and other countries were experiencing a general business depression, not only in agriculture but also in all phases of various industries. Since much of the 1920 crop of cotton was on hand at the time for planting the 1921 crop and since there seemed to be little indication of immediate revival of the activities of the cotton market, the acreage planted in Pima cotton in 1921 was greatly reduced, approximately 76,000 acres having been planted. Table 1 shows the production of American Egyptian cotton grown in California and Arizona since 1912.

TABLE 1.—*Production of American Egyptian cotton grown in Arizona and California since 1912.*

[The statistical data here shown for the years 1912 to 1917, inclusive, were taken from United States Department of Agriculture Bulletin 742 (7),[1] those for 1918 to 1921, inclusive, from the latest ginning reports of the Bureau of the Census.]

Year.	500-pound bales.	Year.	500-pound bales.
1912	375	1918	36,187
1913	2,135	1919	40,437
1914	6,187	1920	92,561
1915	1,095	1921	37,094
1916	3,331	1922	(2)
1917	[1]15,966		

[1] After 1918 the improved Pima variety entirely replaced the Yuma variety, which had been grown in previous years. The planting of Pima cotton began in 1916 with 275 acres, which furnished seed for 6,700 acres in 1917.

[2] Approximately 75,000 acres were planted to Pima cotton for the 1922 crop, which is about the same acreage as was planted in 1921.

The rapid extension of the Pima industry in the World War period was in some respects unfortunate in reducing the general uniformity of the product. Planting was not restricted as in previous years to lands or localities that are well suited to cotton and able to produce regular uniform crops. Many people who had had no previous experience with the crop or with irrigation, or even with farming, undertook the growing of Pima cotton, often under very unfavorable conditions. Thus a considerable number of bales of very irregular fiber have reached the market, with fiber of noticeably different lengths, strength, or condition mixed together in the same bale, a situation which the manufacturers of long staples are especially anxious to avoid.

Prior to the early part of 1921 the consumption of Pima cotton in mills that manufactured fine goods was very limited, for the greater portion of this cotton had been used exclusively for tire yarns and fabrics. During the latter part of 1920 the public began to demand lower prices, so a number of mills using Pima and other high-grade staple cottons in products for the tire trade began to

[1] The serial numbers (italic) in parentheses refer to "Literature cited" at the end of this bulletin.

use the cheaper upper Egyptians and American 1¼-inch staple for this trade. This depression of the cotton market resulted in a more active competition between the Pima and the imported Egyptian cotton, which condition has been a considerable factor in the extension of the utilization of Pima cotton in the manufacture of fine yarns and fabrics.

Up to this time there had been no active efforts for promoting the use of Pima cotton for purposes other than for the tire trade. Spinners of fine yarns were naturally reluctant to buy this new type, being aware of the increased demand for tire fabrics of quality and realizing the rather limited supply of this variety, which was being used extensively for this purpose, so much so that it was generally stated that tire manufacturers had a monopoly of the crop of Pima cotton. Under these conditions other manufacturers could not be assured of additional lots after going to the expense of setting machines for this staple.

Trade fluctuations in the demand for high-grade tires, which were reflected in the market price of Pima, showed the need of developing the use of this cotton in fine yarns and fine fabrics. One of the difficulties now to be met arises from the fact that the requirements for the tire trade as regards trash and methods of handling relative to the production of a clean, smooth staple uniform in length and strength are not as exacting as those for the fine-goods trade.

It is evident that Pima cotton will have to compete with the high grades of Sakellaridis, but to meet satisfactorily and regularly the requirements of the manufacturers of fine yarns and sheer goods some features of the growing and handling of this cotton must be improved. The utmost attention should be focused on the improvement of production on the side of securing greater uniformity of the staple in the individual bales and in even-running commercial lots.

The purpose of this bulletin is to discuss some of the objections current among manufacturers regarding the production, the textile qualities, and the utilization of Pima cotton as found during a cooperative investigation conducted by the Bureau of Plant Industry, the Bureau of Agricultural Economics, and the Arizona Pima Cotton Growers. This information, made possible mainly through the cordial cooperation of manufacturers and cotton factors, will be of value not only to the growers who are in position to produce fiber of the best quality, but also may serve to reassure fine-yarn spinners of the possibilities of improved production of this variety. It is not deemed essential to discuss the superlative textile qualities of Pima cotton, but it is necessary to bring out the various manufacturing problems which when solved by adequate cooperation of the growers will give Pima cotton a better market status.

Since the possibilities of these improvements have been brought to the attention of the growers, they are cooperating in plans for more careful growing and handling in order that fine spinners may have a more uniform type of cotton.

USES AND MANUFACTURING QUALITIES OF PIMA COTTON.

When this country entered the World War in April, 1917, the necessity of maintaining a superior air force was evident. Congress therefore appropriated $640,000,000 for the development of an adequate airplane service (*8*).

The drain on the material resources of the world, especially upon the supplies of flax and linen, had been tremendous, on account of the increased production of airplanes by the other nations involved in the war. Until January, 1917, nothing but linen had been successfully used for airplane wing covering; but as a result of the partial failure of the Canadian flax crop of 1916, the control of the Russian flax and linen stocks by a foreign syndicate, and finally the capture by the Germans of Riga, the export point for Russian flax, the shortage of linen became acute, especially for the United States, as the Allies required all their available supplies for their own airplanes (*8*).

As it required several million yards of cloth to construct the 22,000 machines provided by the airplane appropriation of 1917, it was necessary to find a substitute for linen, and as the American Egyptian, Sea Island, and Sakellaridis Egyptian cottons seemed the most desirable substitutes available the United States naturally turned to that source to relieve the situation (*8*).

Through the cooperation of the Signal Corps of the Department of War, the Bureau of Standards, the Bureau of Plant Industry, and the Bureau of Markets tests of these cottons were conducted, and it was found that the fabric made from any of these cottons was above the requirements of the specifications of the Signal Corps for airplane cloth.

The Pima fabric, made of 2/60s[2] plain weave 80 by 80, weighing 4.23 ounces per square yard, 0.77 of an ounce lighter than the specifications, which is an advantage, was 16 per cent stronger than that required (*8*).

The tire trade does not require as fine smooth yarns as are needed in manufacturing fine goods, and since approximately 85 per cent of the Pima cotton produced was used in the tire trade it has been assumed that fine yarns can not be made from this variety. But the chief requisites for good spinning qualities are length, strength, elasticity, spirality, and fineness of diameter, all of which have been demonstrated thoroughly in many instances in the use of Pima cotton. Much stress is put upon these qualities by some manufacturers, whose analyses of these characteristics vary slightly, though in practically the same ratio.

A manufacturer reports the results shown in Table 2, which were obtained after examining a number of bale samples.

In figures A, B, and C of Plate I[3] may be seen sections of Pima, Sakellaridis, and Sea Island cotton fibers enlarged 250 times. It will be noted that the ends of the fibers are lacking in spirality, which is the case with every variety of cotton.

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[2] The expression "2/60s" is read 2-ply sixties, meaning that two single yarns, No. 60 each, have been twisted together, forming a ply yarn. The expression "80 by 80" indicates that there are 80 threads per inch both warpwise and fillingwise.

[3] Photographs furnished by the Bureau of Standards.

TABLE 2.—*Results of the comparison of bale samples of five varieties of cotton.*

Kind of cotton.	Diameter.	Spirality.
	Inch.	*Inch.*
Pima	0.00060	196
Sakellaridis	.00061	142
Sea Island	.00060	170
Egyptian uppers	.00073	138
Peruvian	.00074	149

Not only is Pima cotton being used successfully in tire yarns and in airplane and balloon fabrics where strength and elasticity are the chief requisites, but it also is being manufactured satisfactorily into fine yarns, handkerchiefs, fine shirtings, dimities, lawns, and voiles. Some mills have woven commercial fabrics of 120s warp and 160s filling from Pima cotton. The writer was in a plant that is spinning 130s filling, using for twist multiplier less than two times the square root of the number of yarn being spun, which means an increase in production for the mill.

One mill that is using Sea Island, Peelers, and Pima cottons is getting a break of 22 pounds per hank on 100s ring spun. The spindle speed used in this case is the same as that used for 85s Peeler in this plant.

OBJECTIONS CURRENT AMONG MANUFACTURERS.

During a recent investigation in the New England manufacturing district many questions regarding Pima cotton were brought to the writer's attention by persons who have had experience in the use of this fiber. However, the possibilities of using Pima cotton for general purposes has not been fully determined, owing to the short time that has elapsed since it was decided to promote the general uses of this variety. Many mills that can use this staple have never heard of Pima cotton and therefore have conducted no tests to determine its working qualities, while there are many unwarranted statements in circulation among those who have had no direct contact with this cotton. In several cases the manufacturers admitted that their opinions relative to the value of the cotton were based upon hearsay. Some of these objections would be serious if they were well founded, while others can be traced to deficiencies in the methods of production and handling the crop. Now that these objections have been brought to the attention of the growers, efforts are being made to correct these imperfect methods

The most serious objections offered by the manufacturers of Pima cotton are as follows:

(1) Too great variation in length of staple.
(2) Poor ginning and rough handling.
(3) High percentage of waste.
(4) Mixed packed bales.
(5) Too many neps.
(6) Production on card reduced.
(7) Considerable amount of "fly."

(1) It is claimed by some who have conducted tests of Pima cotton that the variation in length of the staple is too great. One manu-

facturer states that some of the staple in the same bale runs from 1¼ up to 2 inches. This is no doubt an exaggeration. However, many bales undoubtedly show a considerable variation, which in many cases could be materially reduced by proper methods of preliminary field classing and field segregation.

(2) Much of the cotton shows evidence of rough handling at the gin and compress. The writer inspected many lots of samples of grade No. 2, of which a high percentage were of the rough, ropy type, an illustration of which, reproduced from photographs, accompanies this bulletin. (See Pls. VIII to XII.)

(3) Some of the manufacturers complain of a high percentage of waste in Pima cotton. In one case the total waste for Pima was given as 40 per cent, as compared with 35 per cent for Sakellaridis, Sea Island, or Peelers cotton in the same mill.

In most cases where the same mills were using both Sakellaridis and Pima cotton, the waste content was the same. Some of the New England mills that are making high-count yarns report 32.5 per cent waste for the No. 2 Pima variety.

(4) There have been several complaints of "two-sided" bales, and it is said that in some cases the same bale contains more than two types. A manufacturer who is using much Pima staple said, "The grade is reduced by excess of leaf and the bales seem to be consistently mixed packed." This is no doubt due to the fact that cotton from portions of the field affected by root-rot and that from high spots which have suffered from lack of water have been picked and ginned with the superior cotton.

(5) Pima cotton does have many neps, which are also found in Sakellaridis, though possibly not to such an extent as in the Pima variety. Having seen much Pima cotton in operation in various mills, the writer believes that many neps are caused by improper settings and speeds at the picker and card. This is also the opinion of many of the leading manufacturers who are using Pima fiber satisfactorily.

The yarns shown in Plate II were made at the same mill and reeled from bobbins selected at random. Yarns in section A are made from high-grade Sakellaridis cotton, while the yarns in section D are made from No. 2 Pima, 1⅝-inch staple.

The yarns shown in sections A and B of Plate III were made at different mills from Pima cotton, while C is Sakellaridis and D is Pima made at the same mill. The Sakellaridis cotton broke at 6 per cent above the new Draper standard, while the Pima variety broke 12.4 per cent above the standard.

The yarns shown in Plate IV were all made from Pima cotton at different mills.

Plates V and VI show Pima and Sakellaridis yarns from the same mill.

(6) Some of the manufacturers who have been using Sakellaridis cotton have tried to get the same production from the card on Pima fiber as they did when using Sakellaridis. This can not be done successfully, owing to the difference in length of staple. But the same production can be had from Pima cotton as from Sea Island. Approximately, the production for Pima or Sea Island cotton per card per 48 hours is 220 to 290 pounds, while 200 to 350 pounds of

the Sakellaridis variety can be carded in the same time. These figures vary somewhat, depending upon the class of yarn desired. It is also found that in some cases if the speed of the licker-in is reduced to 350 revolutions per minute more desirable yarns are produced from Pima cotton.

(7) A considerable quantity of "fly" (short fibers) is experienced in the manufacturing of Pima cotton, especially on the drawing frames and the roving frames. This is more noticeable in certain mills than in others, but with one exception there is more fly in the case of Pima than when Sakellaridis is being used. Just what causes this trouble is not definitely known. In one particular case the writer thoroughly examined the "fly" at the drawing frame and it was found to contain many fibers which were at least 1½ inches in length. This does not indicate a fault of the cotton, but is indicative of improper setting and manipulation of the machines. This manufacturer has used a considerable quantity of Pima cotton during the last three years, but has found no way by which this trouble may be overcome. The fibers seem to be "sticky" or rough, so on the drawing and roving frames considerable "licking" is experienced; that is, some of the fibers stick to the rolls, in which case the fibers are taken up by the clearer instead of being delivered with the rest in the form of a sliver or roving, as the case may be. When very many of these fibers stick to the delivery rolls uneven work is produced. However, in another plant a simple inexpensive device is used which materially reduces the quantity of fly. Photographs of fabrics and yarns from this plant are reproduced in this bulletin.

A few manufacturers offered the following less serious objections, which are being overcome by many users of Pima cotton:

(1) More twist required, reducing production.
(2) Uneven yarns and not as strong as Sakellaridis or Sea Island.
(3) Does not retain strength in ply yarns.
(4) Not suitable for thread requirements.
(5) Can not be woven in single warps above Nos. 70 or 75.
(6) Yarns will not mercerize, though fabrics will.

(1) It is claimed by some that more twist is required for Pima than for Sakellaridis or Sea Island cotton, which reduces production. But in the manufacturing plant referred to in the latter part of a preceding paragraph (numbered 7) when a change from Sea Island to Pima was made 10 teeth of twist were taken out of the fly frames, 4 from the slubber, 4 from first intermediate, and 2 from the second intermediate, which gave an increase in production. This mill, which produces some of the finest goods made in the New England district, has used Sea Island cotton for many years and has used the Pima variety successfully for three years.

(2) Much is said about the strength of Sakellaridis as compared with Pima, and in most cases the strength is reported to be greater in Sakellaridis yarns than in Pima yarns. The writer interviewed many manufacturers who stated that they get as high a break from Pima yarns as from Sakellaridis or Sea Island, while others gave the best report for Sakellaridis. According to several tests conducted by the Department of Agriculture, as well as others conducted at manufacturing plants, the difference in the three cottons is practically negligible, for yarns from either come up to or above the new Draper standard. It is further stated that yarns made

from Pima are more uneven; that is, they vary more in diameter than yarns made from Sakellaridis or Sea Island cotton. It will be noted in Plate II, however, that Pima yarns are as smooth as Sakellaridis yarns.

In comparative spinning tests of Pima and Sakellaridis cotton conducted by the Bureau of Markets and Crop Estimates of the United States Department of Agriculture in December, 1921, the results shown in Table 3 were obtained.

TABLE 3.—*Results shown in comparative spinning tests of Pima and Sakellaridis cotton conducted by the Bureau of Markets and Crop Estimates in December, 1921.*

[The percentages of visible waste are based on the net weight fed to the respective machines, except as stated. The breaking strengths (shown in pounds per skein of 120 yards) have been corrected for the variation in the numbers or sizings of the yarns.]

Machines.	Kinds of waste.	Pima cotton (per cent).
Visible waste:		
Pickers:	Opener-breaker motes and fly	6.84
	Finisher motes and fly	.31
Total visible		1.15
Card	Flat strips	3.89
	Cylinder and doffer strips	1.27
	Motes and fly	.97
	Sweepings	.19
Total visible		6.32
Combers	Comber waste	14.05
Pickers, cards, and combers [1]	Total visible	20.30

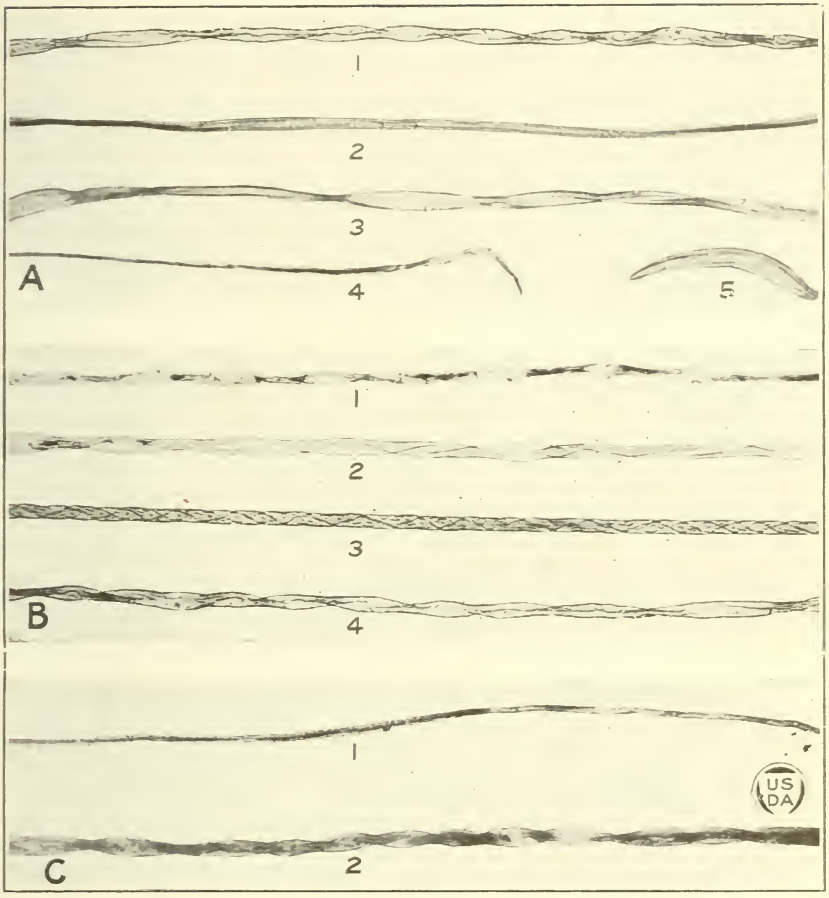
No. of yarn.	Draper standard for combed warp yarns (pounds).	Twist multiplier.	Pima (pounds).
Breaking strength of yarn:			
23s	109	3.2	139.1
		3.5	142.0
		3.8	134.3
Average			138.5
100s	22	3.2	20.5
		2.5	20.7
		3.8	20.2
Average			20.5

[1] Percentage based on the net weight fed to the bale breaker.

The production of card was 295 pounds per 48 hours. The yarn was spun on $1\frac{3}{4}$-inch rings and tested under an automatically controlled relative humidity of 65 per cent.

(3). Pima yarns are said not to retain strength as compared with Sakellaridis when put into ply yarns. Tests reported under date of May 2, 1918, by the Bureau of Markets of the United States Department of Agriculture gave the results shown in Table 4.

The yarns were tested for strength on a single strand tester, and the total stretch of the yarn was taken at the breaking point.



SECTIONS OF COTTON FIBERS.

A, One fiber of Pima cotton: No. 1, center of fiber; Nos. 2 and 4, end of fiber attached to seed; Nos. 3 and 5, free or tip end of fiber. *B*, No. 1, Sakellaridis cotton: Nos. 2 and 4, two different Pima fibers; No. 3, immature fiber. *C*, Sea Island cotton: No. 1, end of fiber: No. 2, section of same fiber showing spirality.

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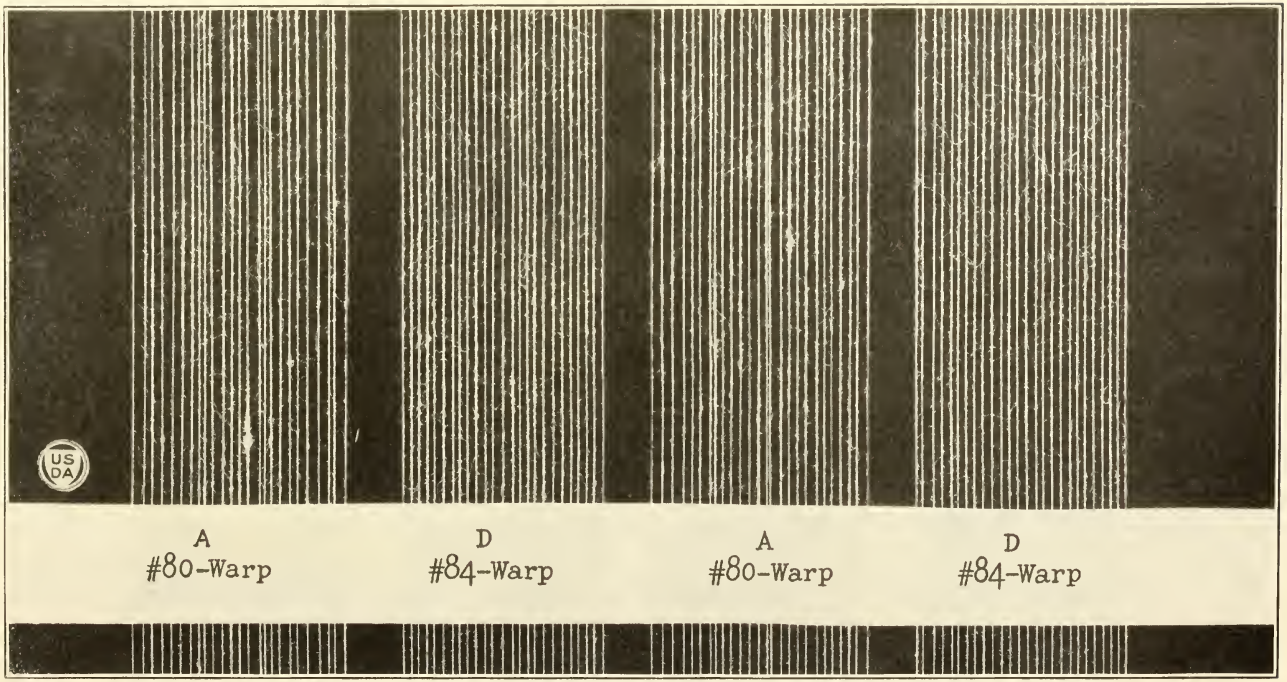
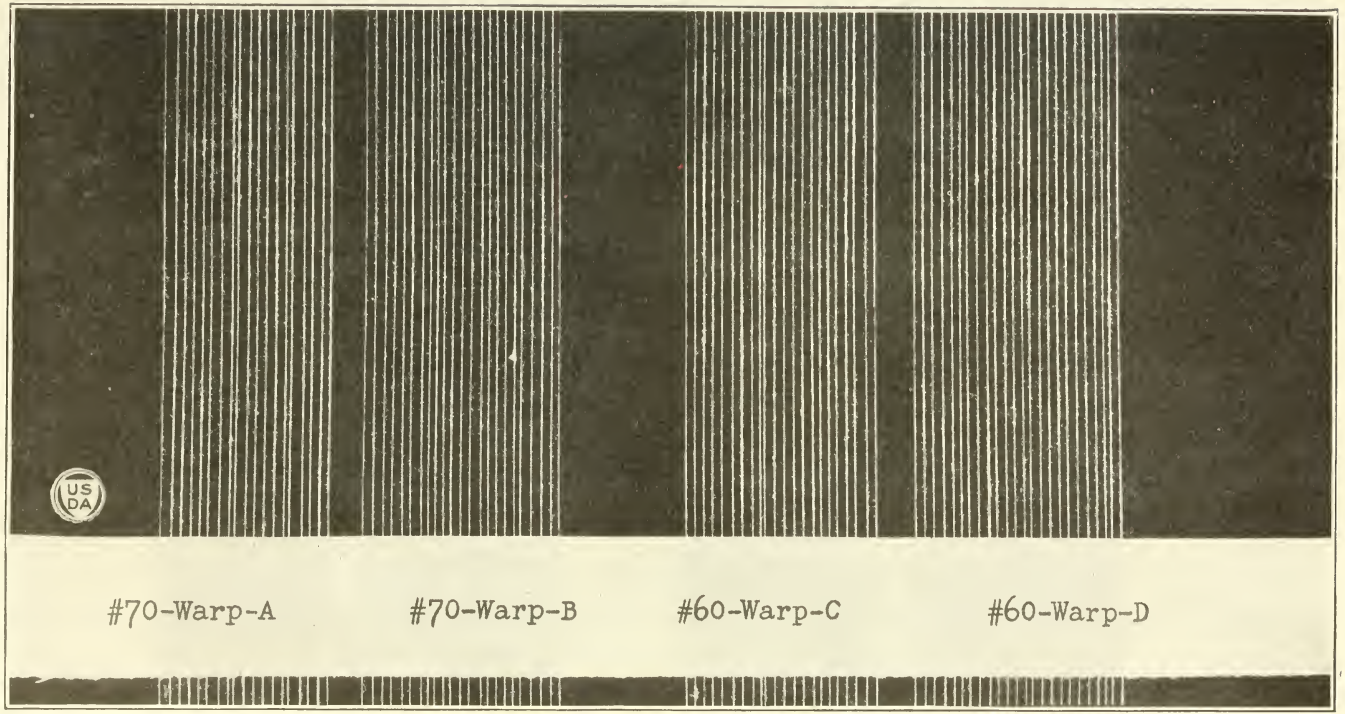
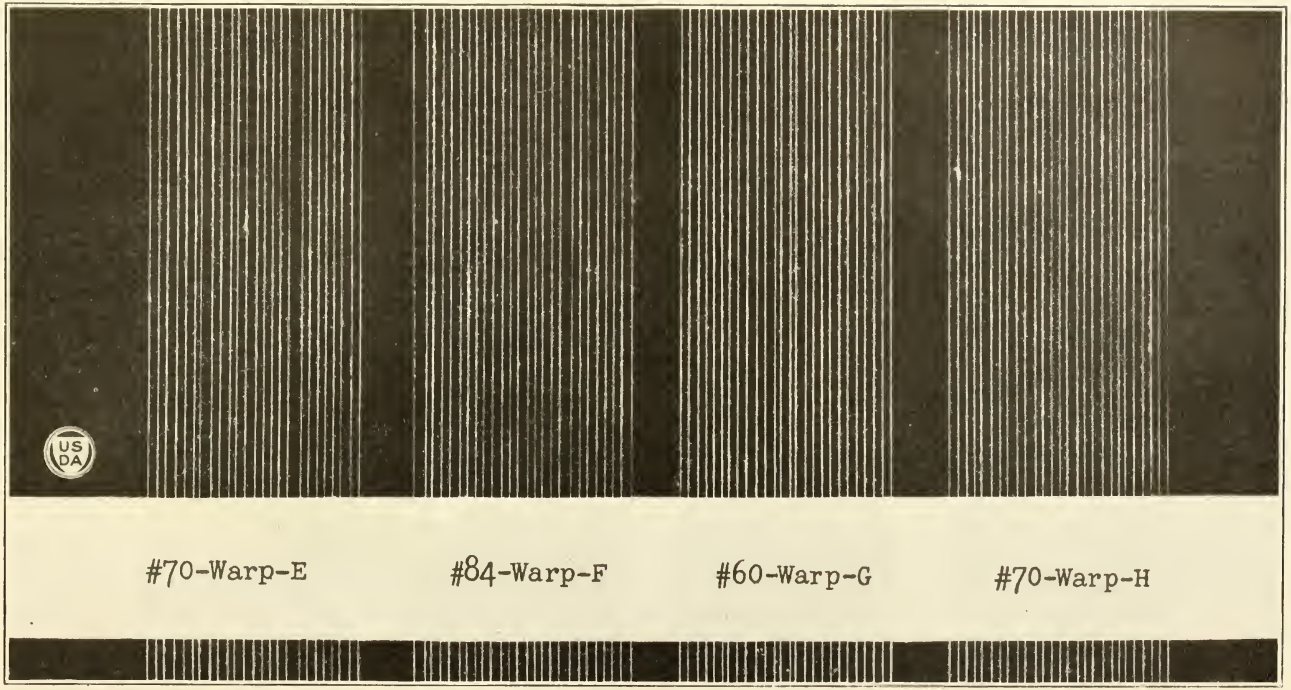


SAKELLARIDIS (*A*) AND PIMA YARNS (*D*) FROM THE SAME MILL.

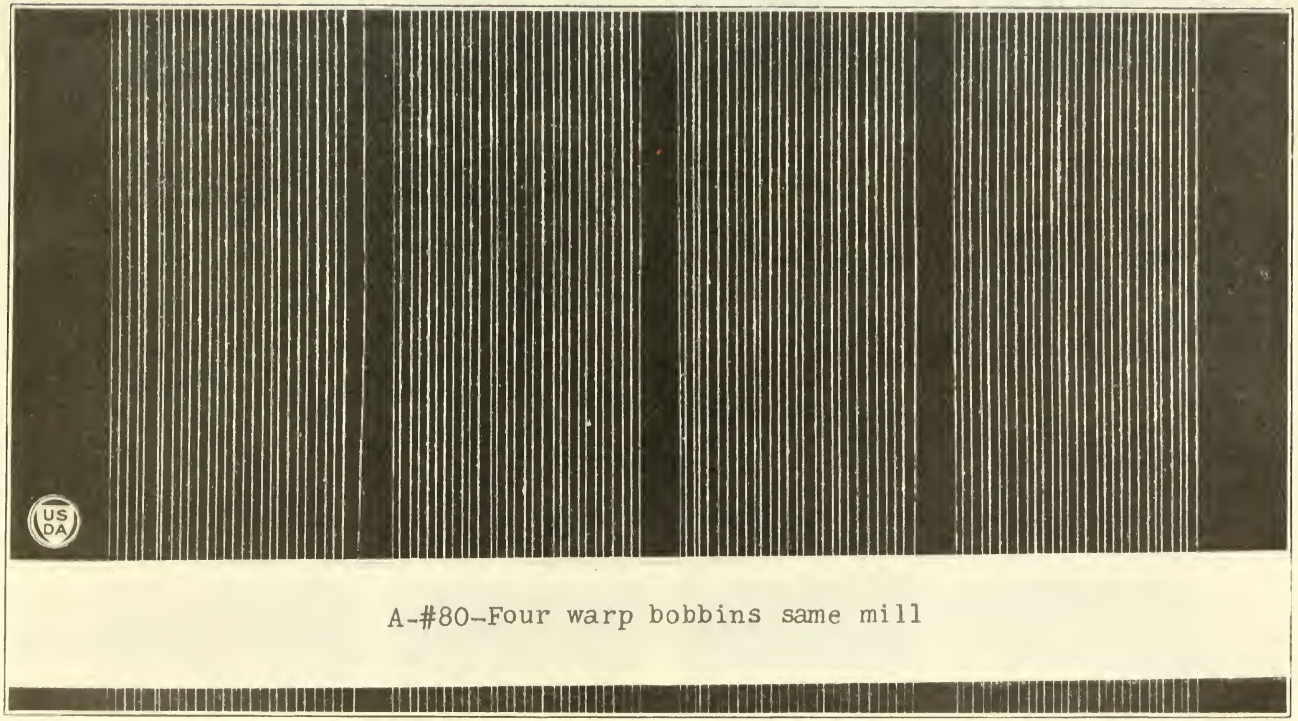


PIMA AND SAKELLARIDIS YARN.

(*A*) and (*B*), Pima yarns from different mills. Sakellaridis (*C*) and Pima (*D*) from the same mill.



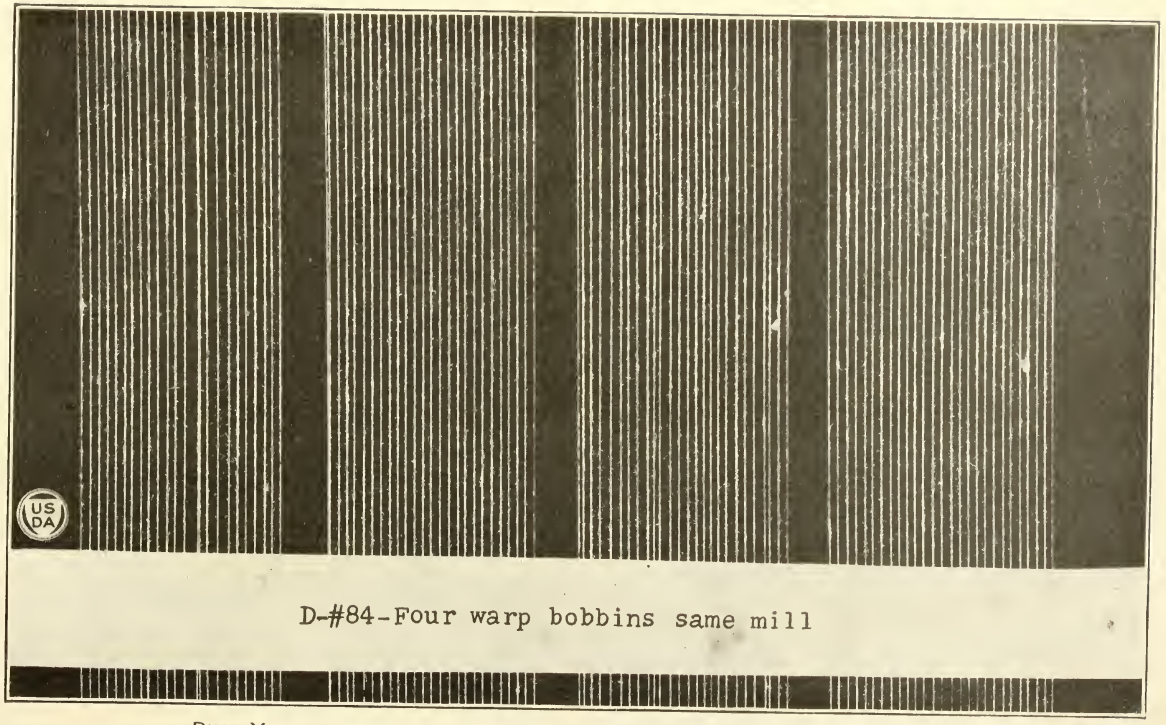
PIMA YARNS FROM DIFFERENT MILLS.



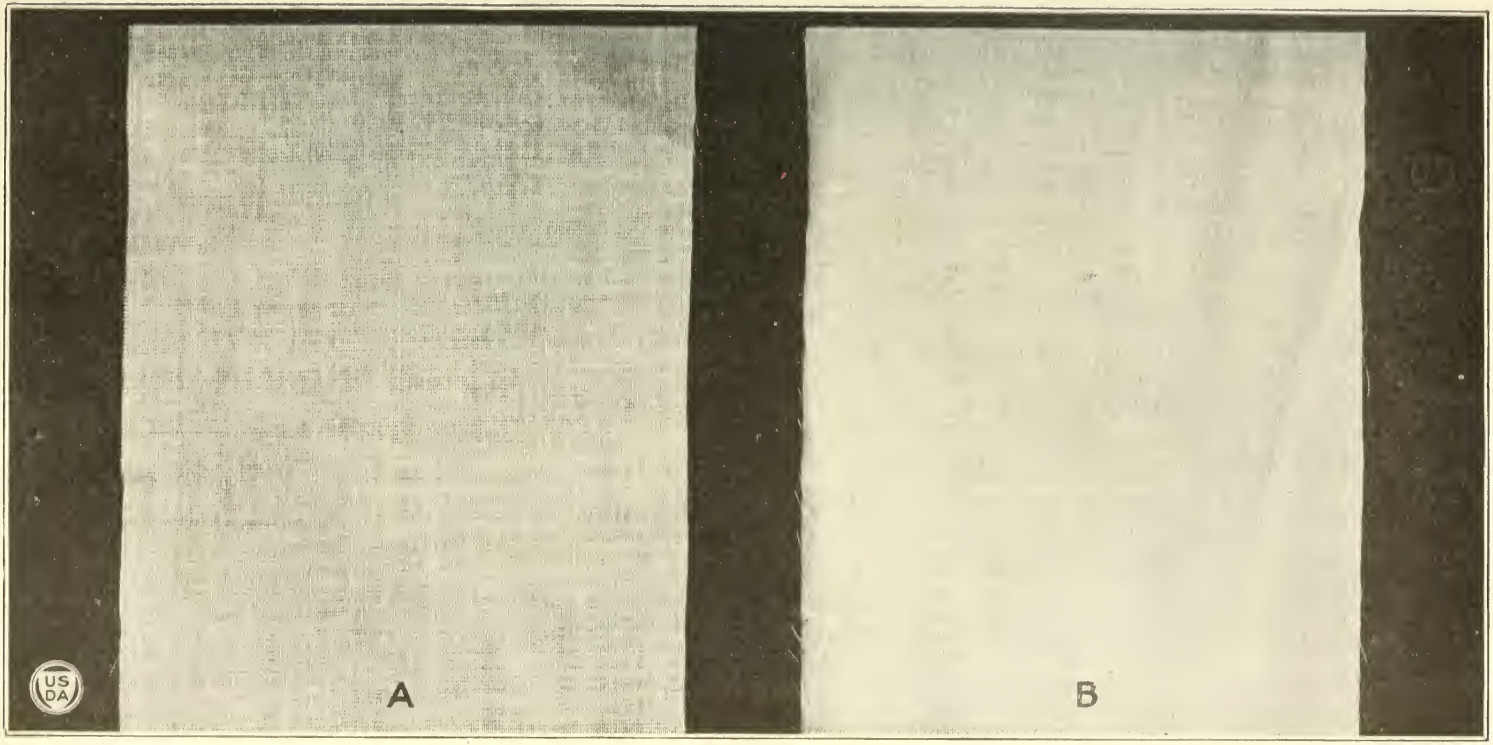
A-#80-Four warp bobbins same mill

PLATE V.

SAKELLARIDIS YARN FROM THE SAME MILL AS THE PIMA SHOWN IN PLATE VI.



PIMA YARNS FROM THE SAME MILL AS THE SAKELLARIDIS SHOWN IN PLATE V.



SECTIONS OF PIMA COTTON FABRIC.

A, Section of 10 fabric, 96 by 92—100s warp and 140s filling; *B*, section of 43 fabric, 112 by 108—85s warp and 120s filling.

TABLE 4.—*Tests of three varieties of cotton by the Bureau of Markets, United States Department of Agriculture, reported May 2, 1918.*

No. of yarn.	Variety of cotton.	Size.	Strength.	Stretch.	Twist.
			Ounce.	*Per cent.*	
80/3	Sakellaridis	80.33	20.80	5.80	20.80
80/2	do	59.97	17.45	5.85	22.20
80/3	Pima	79.54	19.45	7.55	20.40
80/2	do	58.57	17.20	6.85	22.05
80/3	Sea Island	78.75	18.85	5.83	18.35
80/2	do	59.60	15.48	5.23	20.45

It is interesting to note that the Arizona yarns in strength value fall between the Sakellaridis and the Sea Island cottons. It will also be noted that the Arizona yarns show the greatest stretch.

The writer visited a mill that is getting a break of 18 ounces on 2/100 Pima yarn, tested under conditions similar to the above.

(4) Owing to the amount of twist put into the single yarn in making thread and since the highest breaking strength is required in this branch of the trade, only very uniform cotton can be used. The attention of the growers is called to the fact that special methods of selecting and handling cotton for the thread trade must be worked out and followed systematically.

(5) It is further stated that Pima yarn finer than Nos. 70 or 75 single warps can not be woven into fabrics, as the yarn will not stand up under the wear and tension in weaving to which warp yarns are subjected; but the writer has seen Pima No. 100 single warps woven commercially. A sample of this is shown in Plate VII.

(6) The statement that Pima yarns will not mercerize—that is, that they will not give as good luster as yarns made of Sakellaridis Egyptian cotton—was made by at least three mercerizers, but when asked as to the reason for this difference each gave a different interpretation. One claimed that the Pima cotton does not have the body and luster to start with that the Sakellaridis has. He also stated that the yarns made of Pima fiber seemed to absorb the chemicals to a greater degree than the Sakellaridis. The second mercerizer stated his belief that the fibers of Pima are much coarser and more wiry than Sakellaridis, which has a fine, silky, glossy fiber, a characteristic essential in mercerized yarns of high quality. He further stated that he had conducted only a small test, admitting that the yarns used in his test were not given twist suitable for mercerized yarns. The third mercerizer claimed that the fault was due to the chemical structure of the fiber. When the question was pressed upon him, he stated that these yarns could not be mercerized, and that it was useless to make further research for the proper chemical solution and method for mercerizing.

There is no objection to the quality of the mercerization as given to the fabrics made of Pima cotton. The main issue is that yarns in skeins will not mercerize. While on this investigation the writer inspected mercerized Pima yarns which did not have the desired luster, while yarns from other plants had an excellent luster, equaling that given by high-grade Sakellaridis cotton. Through the courtesy of manufacturers and mercerizers five comparative mer-

cerization tests of Pima and Sakellaridis yarns were conducted at different plants; also a comparison of Sakellaridis, Pima, and Sea Island yarns was made. In each case the yarns went through the same process. In one test the Sakellaridis yarns seemed to have a better luster than those of Pima cotton, while in the other four tests there was no difference. Several times the manufacturers selected Pima cotton as having the best luster. Pima yarns when mercerized are as lustrous as Sakellaridis or Sea Island yarns (*9*, pp. 15–16).

It will be noted that Pima cotton is being successfully manufactured into fine yarns and fabrics. The interest in Pima fiber is steadily increasing in the manufacturing districts, and many manufacturers predict a satisfactory outlet for the cotton. It has been thoroughly demonstrated that this cotton is very desirable in manufacturing fine yarns, and this fact has been substantiated by many manufacturers who are using it. One manufacturer states:

> We, as manufacturers of as fine yarns as are made in this country, are seriously interested in the Pima cotton situation, and we hope that by Government assistance and the cooperation of the planters, shippers, and brokers results can be obtained that will make it possible to obtain cotton with extra-long staple; but that cotton to be of any value to manufacturers of fine yarns must be, as previously stated, clean and smooth.

There are many reports very favorable to the Pima cotton industry. However, in this discussion more attention has been given to the more or less well-founded criticisms by the manufacturers of Pima, which show where improvement must be made if the industry is to be a success.

CONDITIONS CAUSING LACK OF UNIFORMITY.

During a recent investigation in manufacturing centers made by the writer it was found that the most serious objections to the introduction of Pima cotton were great variation in length and strength of staple in the same bale, high percentage of waste, and mixed packed bales.

Some of the field conditions which are known to cause a lack of uniformity in the fiber are the presence of root-rot and other diseases, alkali spots, and imperfect leveling, the plants in the high spots suffering from drought and those in the low spots from overwatering.

From his investigations in the Salt River Valley of Arizona, C. J. King, of the Bureau of Plant Industry, states:

> Comparatively early frosts have been responsible for serious damage to the late crop of bolls. It has been estimated by some of the growers that the heavy frost of November 1, 1919, was responsible for destroying from 15 to 20 per cent of the bolls on about half of the cotton acreage in the Salt River Valley. No estimate was made by the writer for the whole valley, but in several fields visited it appeared that from 30 to 40 per cent of the bolls had been destroyed (*4*, p. 4–5).

Certain growers, being desirous of harvesting the crop with as few pickings as possible, often have considerable good cotton open in the fields when the early frosts come, so before the superior cotton can be picked much of this frost-bitten crop opens and is gathered and ginned with the good cotton, which adds materially to the lack of uniformity in spinning qualities.

The selling of certain lots of seed cotton to the owners of the gins is practiced by some of the growers in the valley. This cotton, grown under different cultural methods and in some cases on land that is not well suited to the crop, is mixed, ginned, and baled with no precaution for the possible variation in length and strength of staple. This practice should be discouraged, for it is doubtless one of the causes of mixed packed bales.

The cotton grown under the above-mentioned conditions does not have the same strength or length as that grown under favorable conditions. Under the present system this inferior cotton is picked and ginned with the cotton from the best parts of the fields. As a result the cotton of the best grade and character in the lot is classed with the inferior cotton, instead of the value of the inferior cotton being increased, as some growers believe. These inferior fibers produce a weak yarn, so the manufacturer naturally assumes that the character and strength of the cotton are not suitable for high-grade yarns.

One might put a high percentage of these inferior fibers into a bale of superior cotton and the cotton classer might not detect it, since the strong and the weak fibers have practically the same appearance, but when this cotton is manufactured into fine yarn the weak fibers show up readily.

NEED OF FIELD SEGREGATION.

If all the cotton grown under unfavorable conditions were put into one lot, a fair price could be had for it, since there are certain classes of yarns into which it can be manufactured. Such a process of selection would reduce the amount of variation in the length and strength of staple in the same bale. The high percentage of waste would be reduced, for this inferior cotton would possibly be manufactured into carded yarns only, while the superior cotton, containing only a small percentage of short fibers, would be made into combed yarns. The number of mixed packed bales—that is, having cotton of three or four entirely different characteristics—would thus be reduced.

Field classing and field segregation (*2*) would increase the value of the superior cotton and improve the demand for the better grades of Pima cotton, which would doubtless be equal to Sakellaridis for any class of fine yarns and fabrics, but as long as the cotton is picked and indiscriminately mixed the growers can not hope to receive the premium which the best grades will demand when properly selected.

As regards the presence of several types of cotton in the same bale, an agent of a mill that is using Pima cotton, said:

> This sample shows four types. The smooth clean type represents cotton of this bale we can use in our very finest yarns and make fabric like the cutting inclosed. The rough, ropy type represents cotton objectionable for fine sheer goods, and the other two show cotton really unsuitable for use except in very coarse goods, which could just as satisfactorily be made from low-priced Peeler cotton. We might also say that the bale we refer to was received in a lot of bales, one-third of which lot was rejected, and our rejection was approved by the shipper.

The number of bales rejected is much greater in the case of Pima than in the case of imported Egyptian cotton. For example, a cer-

tain mill rejected more than half of a lot of 300 samples of Pima submitted as No. 1. The writer examined samples of 18 bales rejected by a mill from a lot of 100 bales after buying on samples submitted, which samples showed the rough, ropy type. Another mill rejected 60 bales of a lot of 200. When mills reject cotton it costs them, as well as the shipper, considerable time and money for arbitration. Some mills want a certain type only, and when the cotton does not come up to this standard they will not accept the cotton even at a reduced price, for the reason that it is not suitable for their class of work. A manufacturer stated that he bought imported Egyptian cotton on type and had rejected only one bale in several years. If the Pima growers will establish a similar reputation for their product, and it can be done by proper methods of selecting and classing, one of the most important steps toward the success of the industry will have been taken.

Comparatively few manufacturing plants have sufficient space in their opening room to mix and blend 40 or 50 bales of cotton. Most mills have mixing bins of a capacity of 15 to 25 bales, but there are many mills that have space for mixing 6 to 8 bales at a time. This last case is the one that should be kept in mind when considering the needs of field classing and field segregation of the cotton. When a manufacturer accepts a large order for high-quality goods he must be assured that each mixing of cotton in the opening room will have as nearly as possible the same characteristics as the preceding mixture, so that the entire lot of finished product will be the same. Under the present system of handling the cotton from the fields to the manufacturing centers, there is not sufficient assurance that uniform lots can be had, and it costs the manufacturers considerable to class and separate the cotton according to its different working qualities, so that the desired blend may be obtained. After all this preliminary classing by the various buyers and by the cotton specialist of the mill company, complete assurance is not given that each bale is uniform in content.

Owing to the fact that labor is very cheap in Egypt the cotton is well mixed and blended by hand, both at the gin and at the compress, which accounts for the uniform lots of Sakellaridis cotton, reducing the rejections at the mills to a minimum. But the Egyptian method of producing even-running lots is not economical on the basis of American labor cost. However, the grower in the Salt River Valley can produce even-running and uniform lots of Pima cotton by the proper system of field classing and field segregation, which could be perfected and executed at a very small cost to the growers; in fact, it would not be a liability but an asset, for such a system properly carried out would be a considerable factor in creating a demand for Pima cotton.

CLEAN UNIFORM STAPLE ADVANTAGEOUS TO MANUFACTURERS AND GROWERS.

When it is considered that from 25 to 36 per cent of the cotton used in the manufacturing of fine yarns and sheer goods is discarded as waste, the urgent necessity for improved plans of production that will greatly reduce this high percentage of waste by producing a staple that is uniform in length and strength is evident. The waste

consists of motes, foreign matter, and "fly," or short fibers, which is partly a result of careless picking and ginning, partly of unequal conditions of production, and in some cases the result of mixed seed.

In the commercial production of select varieties of cotton uniformity has doubtless received less attention on the part of the growers than any other of the manufacturing requisites. Except a small quantity that has been produced by individual farmers rather than on a community basis, very little cotton that has ideal manufacturing qualities has been commercially produced. Though certain varieties having superior textile characteristics have been bred, careless handling has kept satisfactory uniformity from being attained; hence the cotton becomes of less value for spinning purposes. Manufacturers who are producing high-grade fine yarns and fabrics frequently pay a premium for cotton that is free from waste and is uniform in length and strength, from which class of cotton an increase in production can be had, which means a decrease in the manufacturing cost per pound; and there is no reason to believe that the growers of Pima cotton will not receive a premium for well-selected and properly handled staple over that which is picked, ginned, and baled with no attention given to the different lengths and types of fiber.

In the various manufacturing processes the pickers, cards, and combers remove practically all the short fibers, motes, trash, and other foreign matter. From cotton that is to be made into fine yarns the pickers remove from 2 to 6 per cent of the waste; the cards remove from 6 to 10 per cent of the waste, the greater portion of which is short fibers known as flat, cylinder, and doffer strips; the combers remove from 14 to 20 per cent of short fibers as waste. The percentage of waste removed by these machines depends upon the uniformity of the cotton as well as on the desired quality of finished product. However, the flat strips and comber waste are not a total loss to the manufacturers, as they can be made into low-count yarns and usually sell on the market for 40 to 75 per cent of the price of Middling cotton, depending upon the demand for this class of waste.

The lack of uniformity is found not only in Pima cotton but also in other varieties, whether grown in the United States, Egypt, or elsewhere. The best varieties grown in Egypt are mixed, necessitating much labor in sorting and blending after picking is completed. After his study of the cotton production in Egypt O. F. Cook (*1*) states:

> Inspection of many cotton fields in different parts of Egypt shows that the so-called Hindi cotton is a general contamination of the Egyptian stock, responsible for a large amount of diversity and degeneration. Breeding experiments have shown that it is possible to secure a much higher degree of uniformity in Arizona than now exists in most of the cotton fields in Egypt.

It is practically useless to produce good cotton if by a careless system of harvesting and handling the superior cotton is to be mixed with the inferior cotton, which must be separated in the mills by the expensive operations of picking, carding, and combing. It is not hoped to produce a cotton that will be so uniform that combing—an operation by which the superior fibers are parallelized and the short fibers removed—will not be necessary in manufacturing fine yarns, but this mixing of short inferior fibers with the best

staple can be materially decreased if adequate supervision is given to field segregation.

BETTER METHODS OF GINNING.

Another important step in producing cotton that will be satisfactory to the manufacturers is to improve the method of ginning, an operation to which too much attention can not be given. Much of the Pima cotton now reaching the eastern markets shows conclusively that it has not been properly ginned. One manufacturer who uses this variety said, "The ginning appears to be carelessly done, and there seems to be evidence all along the line of an utter lack of appreciation of what the requirements are in long-staple cotton, which by its length and fineness is naturally suitable for fine yarns." The writer examined several lots, 50 samples each, of Pima, a high percentage of which showed the rough, ropy type, which is unsuitable for the manufacture of fine, sheer goods. In Plate VIII it will be noted that half of the sample is smooth, while the other half is very ropy and stringy. This sample was drawn half from each side of the same bale. It is rather difficult to illustrate these undesirable characteristics by photographs, so samples have been mailed to the growers for their examination.

What mill men call "curl," "flock," and "cut seed" in cotton may be seen in Plate IX. A manufacturer who is an extensive user of Pima cotton submitted this sample to this department and stated that these faults in cotton of this classification make it practically valueless for the purposes to which it might be put if smooth and clean.

It is not definitely known at just what point in the ginning or handling processes the cotton receives the treatment that causes this rough, ropy character, but the following suggestions as to the possible cause have been given by persons who have had much experience in handling and manufacturing cotton:

It may have been ginned wet or green.

After ginning it may have been placed where it absorbed moisture and then was compressed when damp.

It might have absorbed moisture after compression.

Cotton from two different plantations or sections may have been run together, or two entirely different grades may have followed each other at the gin.

Cotton grown under adverse conditions may have been mixed with that grown under favorable conditions.

Very often in ginning there is too much friction between the rolls and the knives, and this generates considerable heat. To correct or overcome this a light application of water is made, and while the rolls are in this moist condition the lint delivered has this wadded, rough, ropy appearance.

The last part of the lint often comes in driblets instead of in one continuous sheet; these driblets or small sheets of lint show as separate pieces, and if they are damp they are likely to retain a rough, lumpy appearance after pressing.

In a report on the handling and marketing of American Egyptian cotton in 1914 J. G. Martin (*5*, p. 3) found numerous reasons for the poor condition of some cotton. He states:

The storage capacity for seed cotton at the gins was inadequate during both seasons, and as there were no seed-cotton houses on the farms the cotton in a great many instances had to be piled in a corner of the field on the ground until enough could be accumulated to make up a wagonload. The majority of the farmers live at a considerable distance from the gins, and the expense

of hauling only a fraction of a wagonload is prohibitive. At the same time, the cotton left on the ground was subject to damage by exposure to heat, heavy dews, and rains. Seed cotton, loaded in wagons, was left standing in the fields, in barnyards, and at the gins. The cotton neglected in this manner was subject to damage by exposure, as it absorbed a certain amount of moisture and was ginned damp. Damp or wet cotton does not gin smoothly, but produces a curly and matted condition of the fiber, which lowers its grade and value. Unfortunately, the result was very marked in this case. In January, after a period of rainy weather which lasted several days, some of the cotton was so wet when ginned that the friction of the rollers against the knife edge heated the cotton greatly, thus subjecting it to undue damage. The curly condition due to the ginning of wet cotton was very noticeable after each rain.

Doubtless the moisture applied at the gin and the quantity that may be absorbed when cotton is stored on the ground before compressing plays an important part in causing the cotton to maintain a rough, wadded appearance. One cotton specialist who has used much Pima fiber states, "I can tell practically every time by the odor of the cotton as to whether it is smooth or of the rough, tangled type by the peculiar musty odor." Some of this cotton examined by the writer had an odor similar to mildewed cotton, though no other signs of mildew were noticeable.

Very often the cotton contains hulls or cut seed, immature seed, and seed from which the lint has not been ginned. These conditions were observed in samples at a warehouse, at a cotton broker's office, and at a manufacturer's office. The sample from the warehouse contained 70 seeds from which the lint had not been ginned, half of which seeds have been ginned and are shown in Figure 1. To a manufacturer who had not used Pima cotton 48 samples were submitted, from which lot he was to select 25. Two samples in the returned lot of 23 contained hulls, seed, and seed cotton, all of which are very objectionable in manufacturing. The fact that the newly interested manufacturer forms the opinion that possibly the whole crop is handled in this careless manner is most injurious to the Pima cotton industry.

Plate X shows a sample of Pima cotton just as it came from a mill that is using much of this variety for very fine yarns and fabrics. Note the seed and hulls, as well as the rough, tangled appearance of the cotton.

In the mill these seeds are often removed at the first machine, the picker, while others are crushed and broken into fine particles, which give the manufacturer much concern. To quote from the "question and answer" section of "Cotton," January, 1922, "Taking up the third question—asking whether there is a remedy that will stop small particles of cotton seed and other foreign matter from lodging in the card flats—I want to say that there is no other evil in a cotton mill where an ounce of prevention is worth a pound of cure more than here." The writer then gives a possible remedy. But the "ounce of prevention" could be used at the gin to great advantage not only to the manufacturer but also to the growers in that a reputation for well-handled properly ginned cotton will be built up. If a community growing one variety of cotton is to find a profitable market from year to year, it must at all times keep the idea of quality before the people interested in the industry.

Plate XI shows rolled and tangled pieces taken from a sample submitted by a mill using Pima cotton. This condition was due to bad ginning.

Plate XII shows badly ginned Grade No. 1 Pima cotton, as contrasted with the smooth, well-ginned Pima shown in Plate XIII.

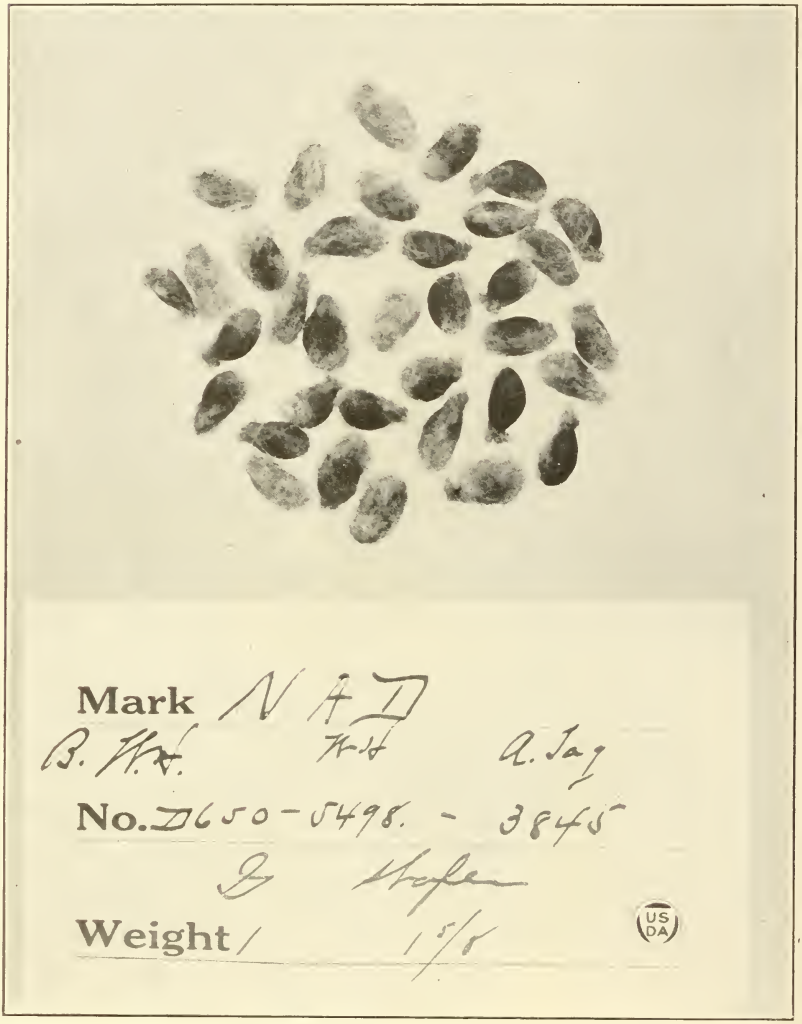


FIG. 1.—Half of 70 seeds in a sample found in a warehouse.

SAMPLING OF BALES.

Promiscuous sampling of the bales should not be permitted. Many bales of Pima cotton before leaving the Salt River Valley have been cut and resampled six or eight times. The growers' organization should sample the cotton, keeping half of the original sample for

SAMPLES OF COTTON DRAWN FROM THE SAME BALE.

Upper half, drawn from one side of the bale, smooth; lower half, drawn from the other side of the bale, rough and tangled.

COTTON SAMPLE SHOWING CURL, FLOCK, AND CUT SEED.

COTTON SAMPLE SHOWING CUT SEED AND TANGLED AND ROUGH FIBER.

ROLLED AND TANGLED PIECES OF COTTON.

These were taken from a sample submitted by a mill using Pima cotton. The rolling and tangling shown is due to bad ginning. (Natural size.)

GRADE NO. 1 PIMA COTTON BADLY GINNED.

SMOOTH AND WELL-GINNED PIMA COTTON.

arbitration, should that be necessary, while the other half would be submitted to the prospective buyer for his examination. In order to make this plan effective it would be necessary that the organization guarantee that the sample is representative of the contents of the bale. It may be noted from the photographs of bales (figs. 2 to 5) that many of the cuts made in sampling are not patched at the compress, causing a considerable loss to the growers.

COMPRESSING.

A step in handling of no less importance than sampling is compressing. A few years ago some of those interested in the manufacturing of tire fabrics claimed that Pima was "air cut" when compressed. This question was taken up with the various manufacturers in the New England district, and it is the consensus of opinion that this cotton can be compressed at a slow rate to a density of 22 pounds per cubic foot or slightly more without any damage to the fiber.

One of the New England mills which is using much Pima cotton has just completed a test for the growers of Arizona on five bales (Grade No. 2) of compressed Pima cotton. Its report is as follows:

> The spinning value of this cotton has not been injured in the compressing of these bales; in fact, they were a very good lot and better, in our opinion, than the average run of this cotton, as the test will show. The waste from all sources showed 32.367 per cent, and of this amount there was 0.01879 per cent of invisible waste.

Many other mills which the writer visited are using compressed Pima cotton, which is working satisfactorily so far as this matter is concerned. The advantage to the mills is considerable, in that much less space is required for storage, but it is of more importance to the growers in what they save in transportation and storage charges. Under the growers' present plan of storing the cotton in the East until a market can be had the question of rates on compressed as compared with uncompressed cotton should have first consideration. For example, the rate for storage is 85 cents for the first month and 45 cents for each month thereafter for uncompressed cotton, while for that compressed the rate is 55 cents for the first month and 25 cents for each month thereafter.

The freight rate on compressed cotton is $2.08½ per 100 pounds, while the rate on uncompressed bales is $2.44½. Much of this cotton is stored in the East for more than three months. The charges on a 500-pound bale stored for three months only are as follows:

Uncompressed cotton:	
Freight, 5×2.44½ per 100 pounds	$12.22½
Storage, first month	.85
Storage, second and third months at 45 cents	.90
Total charges	13.97½
Compressed cotton:	
Freight, 5×2.08½ per 100 pounds	10.42½
Storage, first month	.55
Storage, second and third months at 25 cents	.50
Total charges	11.47½
Saving per bale	2.50

Much of the Pima cotton in the East is compressed, and the writer had an opportunity to inspect a great deal of it in several warehouses and manufacturing plants. About 60 per cent was found in very poor condition. The worst of the imported Egyptian cotton in these warehouses is in as good or better condition than the best of the Pima.

Some of the Pima cotton is compressed en route at points in Oklahoma and Texas. None of these compresses are doing satisfactory work. The photographs reproduced in Figures 2, 3, and 4, taken during the investigation in New England, illustrate two important defects in the present method of compressing Pima cotton. Figure 2 shows three common faults. (1) The bagging, being imperfectly sewed over the ends, comes loose, and the cotton gets very dirty,

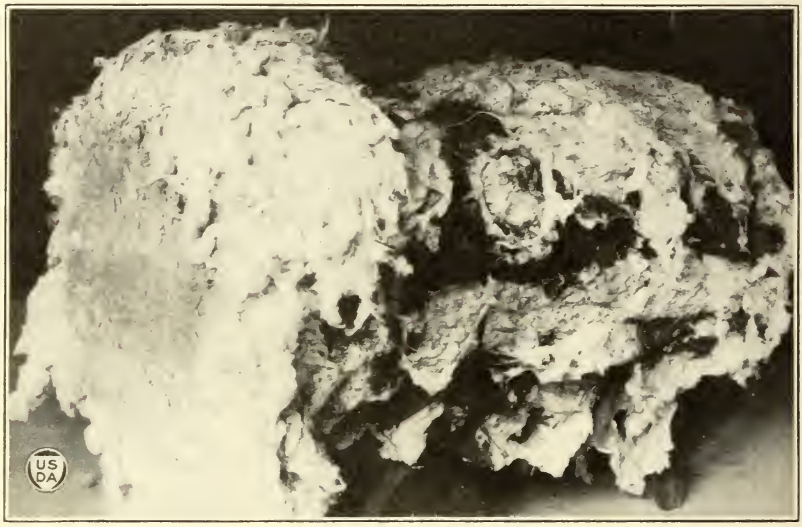


FIG. 2.—Bale of Pima cotton compressed, showing the broken band and the poor quality of bagging, which was not sufficiently sewed over the end of the bale.

being often tangled with shavings and small pieces of jute, both of which are very difficult to remove and cause much waste in manufacturing. (2) Often a band, more commonly the end one, is broken, which allows the cotton to fluff out and more readily pick up foreign matter. (3) The bagging is of very poor quality and exceedingly ragged. It will be noted that the bale illustrated is on a truck, yet the cotton is so loose and stringy that it touches the floor at the end and side, which shows that when such bales are transferred much cotton is detached, becoming waste, which causes the grower considerable loss.

The bale shown in Figure 3 illustrates a different result of poor handling at the compress; that is, only the ends and sides are covered, while both faces are completely uncovered. It will be noted that the cotton shown on the left side of the bale, the fourth band from the bottom, hangs loosely almost to the second band from the bottom, while on the right it hangs from the third band from the bottom to within a few inches of the floor. As the two large samples

FIG. 3.—Bale of Pima cotton subject to damage on account of the sides of the bale not being properly covered at the compress.

of cotton on the floor dropped off while this bale was being transferred a distance of approximately 15 feet, it is evident that a considerable quantity would be lost during loading for shipment and unloading at the mill.

FIG. 4.—A bale of Pima cotton compressed, showing the poor quality of the bagging used, the cause of much loss in weight in transferring the bale to eastern points.

The bale shown in Figure 4 might be classed as an exceptional case, as there was no other bale in the warehouse just like it, though several manufacturers stated that they had received similar bales.

The conditions illustrated are the cause of much loss in weight by the time the bales reach the mills. Three years ago a mill bought 500 bales of Pima cotton which were received in a condition similar to that shown in the accompanying illustration. In this shipment there was a shortage of 30 bales, which shortage the railroads made good, since they were not only the carriers, but also supervised the compressing.

Figure 5 shows four bales of Pima cotton that were received by the United States Department of Agriculture and forwarded to the

FIG. 5.—Four bales of Pima cotton compressed. Note the pile of cotton at the right center of the floor that has fallen out of the poorly covered bales.

Bureau of Standards during August, 1921, for a special test. Five pounds were dropped from these bales while they were being trucked over a distance of 30 feet. The general condition of the bales, as well as the waste at the right center of the floor, is shown in the illustration. The bagging being carelessly sewed, the ends have come loose, leaving the cotton exposed, which is the cause of considerable loss to the growers.

The rough, ropy appearance of the cotton near the end of the first bale is evident. This is caused by poor ginning, which is one of the chief objections made by users of Pima cotton.

The present method of the Arizona Pima cotton growers of classing according to grade and staple is very desirable, but full returns can not be had so long as the bales are put up in this careless manner.

STORAGE OF BALED COTTON.

It is the belief of some of the growers that the lint cotton left exposed to the weather suffers no serious damage. There are several thousand bales of Pima cotton that have been stored in the open in the Salt River Valley for 12 to 14 months. Some of this cotton was examined by the writer, and it is believed that in many instances there are approximately 25 pounds of cotton on the ends or sides of the bales that have been next to the ground that are absolutely worthless for spinning purposes. The bagging having been subjected to the weather conditions of the valley is very weak and rotten, so the bales are very ragged when they are received in the eastern manufacturing centers.

It is very evident that the cotton should be stored as soon as ginned, for the growers are suffering considerable loss each year from country damage.

PLACE OF PIMA COTTON IN THE LONG-STAPLE MARKETS.

The commercial production of Sea Island cotton in the Southeastern States has been materially reduced on account of the spread of the boll weevil. The following statement indicates the rapid decline in the production of Sea Island cotton since 1916 (*6*, p. 2):

Year.	Bales.	Year.	Bales.
1916	117,559	1919	6,916
1917	92,619	1920	1,868
1918	52,208	1921	[1] 3,327

[1] It is generally believed that a considerable quantity of Meade cotton was placed on the market as Sea Island.

According to current reports the cotton acreage in Egypt for 1922 was less than in 1921.

Several superior varieties of cotton have been developed in Egypt, only to deteriorate in a period of 10 or 15 years. It is generally conceded by manufacturers that Sakellaridis Egyptian cotton has deteriorated very much in the last two years. This is evidenced by the following statement from a prominent manufacturer:

> For our finest yarns Sakellaridis Egyptian has not been found to have a suitable long staple, but we did find it in the Pima cotton, which seemed to be much better than the Sea Island produced in recent years and a cotton we could use to replace Sea Island.

Inadequate methods are used in Egypt to maintain a pure variety of cotton.

With these possibilities of a shortage of staple cottons, and since a supply of pure Pima seed (*3*) is maintained, it is in the interest alike

of farmers and manufacturers who are desirous of having a regular supply of uniform cotton to encourage the production and promote the use of Pima cotton.

During 1921 special supervision was given to the ginning and grading of approximately half of the crop. The cotton was graded and classed in uniform lots according to staple, which proved advantageous to the manufacturers. Plans are being formulated to produce a more uniform lot of cotton from the 1922 crop.

IMPROVEMENTS FOR THE STABILIZATION OF PIMA COTTON.

A conference, attended by bankers, growers, members of the State Farm Bureau Federation, and members of local organizations, was held in Phoenix, Ariz., April 4 to 6, 1922, for the purpose of formulating plans for the improvement of growing, handling, and promoting the use of Pima cotton. The necessity of bettering conditions in the industry by improving the methods of growing, ginning, baling, and storing was recognized, and the following recommendations by the committee were adopted by the conference:

Planting pure, selected seed on land especially suited for cotton production.
The most advanced cultural methods.
Field segregation and classing.
Careful picking and handling to avoid mixing types.
The most improved methods of ginning, baling, and storing.
Careful sampling and efficient classing as to grade, staple, and type.
Proper warehousing or other protection to prevent country damage.
Intelligent compressing not injurious to this type of cotton.
The delivery to the manufacturer of cotton in well-covered bales in a desirable condition, equal to that of any cotton placed on the market.

THE VARIETY GROWN.

It is recommended that the production of Pima cotton be continued until there is satisfactory evidence that some other variety can be grown more profitably. The fundamental importance of growing only one kind of cotton is recognized, and it is believed that haphazard experimentation with other varieties is bound to result in mixture of seed and loss to the community of its reputation for producing a uniform and superior cotton. It is strongly urged that if at any time in the future a change to some other variety should be deemed advisable the substitution should be made in an orderly manner and with due precaution to avoid mixture of seed.

THE PLANTING SEED.

Recognizing the fundamental importance of pure planting seed as a requisite to the production of uniform cotton of superior quality, we recommend the continuation of the present method of maintaining purity of the planting seed by roguing seed fields, increasing the seed from the rogued fields under proper conditions of isolation, and distribution of the seed from the increase fields to the growers under certification.

We also recommend that the cost of providing a supply of certified planting seed adequate for all contingencies be distributed equitably among the cotton growers of the Salt River Valley.

UNIFORMITY IN THE BALE.

We recognize that under existing conditions much of the cotton produced has reached the consumer in bales the contents of which lack uniformity; in other words, that in many cases all of the cotton in the bale is not exactly like the sample.

We recommend the inauguration of a system of field segregation, gin inspection, and bale certification, to the end that the individual bale shall be

uniform, not only as to the grade but also as to the length, strength, and type. A system of field inspection should be inaugurated and a number of inspectors employed, whose duty it shall be to locate and mark off in the field spots where, for one reason or another, the cotton is likely to be of different character from that of the rest of the field, in order that the cotton from such spots may be picked, ginned, and baled separately. This inspection should follow the cotton through the gins in order to make sure that no mixing of the separately picked cotton takes place in ginning and to guard against the mixing of badly ginned cotton in the same bale with that which has been properly ginned. All bales of cotton which have been picked and ginned under conditions approved by the inspector should be entitled to a certificate stating that to the best of his knowledge and belief the contents of said bale are of uniform character.

COMPRESSING PIMA COTTON.

We recognize the importance of making provisions whereby it may be possible for Pima cotton to reach the manufacturer in the best possible condition. To this end we favor the erection of a central compress here in the Salt River Valley which may be under the supervision of the associated growers and which may turn out a distinctive type of bale. We believe that such a compress would result in a material saving to the industry through better transportation and storage rates and that the commercial value of our product would be relatively higher than it now is under existing methods of compression in transit.

PROMOTING USE OF PIMA COTTON.

We recognize that the law of supply and demand is supreme and inexorable, and that it governs the price of Pima cotton as well as of other commodities. We believe that stocks of Pima on hand are not excessive in view of the world's requirements for such cotton. We think, however, that the demand for Pima is far below its merits and we recommend that concerted effort be made to encourage the increased use of this superior commodity.

In accordance with these resolutions plans for certain improved methods in production, ginning, and handling the cotton were formulated and carried on in connection with the 1922–23 crop. Experiments in relation to field segregation and gin improvements are being conducted, the results of which will be published when tests are complete.

CONCLUSIONS.

Pima cotton has been manufactured successfully into tire yarns, tire fabrics, balloon cloth, and airplane fabrics, where strength and elasticity are the chief requisites.

Pima cotton is being manufactured satisfactorily into fine yarns, fine shirtings, dimities, lawns, and voiles. Yarns made of Pima cotton when mercerized are as lustrous as Sakellaridis or Sea Island yarns.

Pima cotton grown under suitable conditions and properly ginned and well handled is equal to either Sea Island or Sakellaridis cotton for the manufacture of fine yarns and sheer goods.

Many of the criticisms offered by manufacturers can be entirely avoided by proper production methods.

Field inspection and field segregation will avoid the mixing of the inferior cotton from high spots, root-rot, and alkali spots with the cotton that is grown under favorable conditions. Such a system properly carried out will reduce the variations in staple, the high percentage of waste, and the number of mixed packed bales now encountered by the manufacturers.

It is absolutely essential that all the cotton in the same bale be of uniform length and strength, clean, smooth, and well handled and ginned. Cotton of this character may be produced either under uniform cultural methods or by field segregation.

The methods of ginning should be studied and improved so as to avoid an excess of seed and hulls in the lint cotton, to reduce the high percentage of what the manufacturers call "flock" and "curl" and to diminish the quantity of rough, ropy, tangled cotton.

A clean smooth cotton, suitable for fine yarns and sheer goods, can be produced under the above suggested conditions. By carrying out these plans a reputation can be built up which will be a considerable factor in securing a satisfactory market for the cotton from year to year.

Promiscuous cutting and sampling the bales should be discouraged.

Pima cotton should be compressed, as it will mean a substantial saving to the growers in freight and storage rates. Also, the mills prefer the compressed cotton, as it takes less storage space.

Mill tests have been conducted which indicate that compressing in no way lowers the spinning value of the cotton. A slow rate of compression is to be preferred.

The growers should have their own compress, so that proper supervision can be given to the operation. It is very important that the bales reach the Eastern markets in better condition than those shown in the accompanying illustration, reproduced from photographs, which give a fair representation of the bales as they are delivered at the mills at the present time.

The cotton should be stored as soon as possible after ginning, so as to avoid country damage.

Owing to the shortage of Sea Island cotton, the possible reduction in acreage of Sakellaridis Egyptian, and the likelihood of the further deterioration of this variety, it will be advantageous to the growers and to the manufacturers to encourage and promote the use of Pima cotton.

Essential improvements in methods of handling were made in 1921, and plans for further improvements in ginning and in field segregation have been adopted.

The growers realize the importance and necessity of these improvements and are giving their cooperation in solving these problems.

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